ENVIRONMENT ACT

ACT WASTEWATER REUSE FOR IRRIGATION

ENVIRONMENT PROTECTION POLICY

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1 INTRODUCTION

1.1 What is the purpose of this EPP?

The guidelines in this Wastewater Reuse Environment Protection Policy (EPP) are designed to help people understand and apply the Environment Protection Act (the Act) and Regulations as they apply to water. There are general offences in the Act which carry substantial penalties. The EPP provides guidance on meeting these legislative requirements.

This EPP also sets out health and planning requirements for wastewater reuse to assist developers and operators of reuse systems with these requirements. The health requirements have been developed on advice from the Health Protection Service, ACT Department of Health and Community Care.

There is increasing recognition of the need to make more efficient use of available water supplies. While the discharge of suitably treated effluent to the river system is important for the maintenance of environmental flows in ACT waterways, the beneficial reuse of treated wastewater is encouraged to minimise demand on potable water supplies and off-stream diversions which may adversely affect aquatic ecosystems.

In the ACT, effluent reuse trials commenced in 1977 when chlorinated effluent from the Fyshwick Sewerage Treatment Plant was first used to irrigate a selection of Royal Military College Duntroon playing fields. More recently, trials have commenced which aim to assess the potential for reusing treated domestic wastewater around the home for irrigation and for toilet flushing. The irrigation of Southwell Park in Lyneham using wastewater "mined" from a nearby trunk sewer and treated to meet high levels of public health and environmental standards, represents another recent wastewater re-use initiative.

This EPP, which promotes practices to minimise the risk to public health and the environment, has been developed in response to the initiatives outlined above and in anticipation of an increase in proposals to implement similar schemes.

In addition, this EPP explains the levels of environment protection and general performance which the Environment Management Authority (the EMA) will use to determine if the reusers of wastewater have adopted the general environmental duty as specified in the Act.

The *Water Resources Bill 1998* contains provisions which are relevant to the management of water resources.

1.2 Administration consistent with Objects of the Act

Section 3 of the Act requires that the Act be construed and administered consistently with the Objects of the Act. This EPP should be read and applied to best give effect to the Objects of the Act.

2 Policy objective

The objectives of the Wastewater Reuse Environment Protection Policy are to:

- promote the more effective and efficient use of available water resources through facilitating the beneficial use of wastewater; and
- in so doing, ensure public health and environmental protection concerns are fully addressed.

3 Scope of Guidelines

The Wastewater Reuse Environment Protection Policy is intended to:

- identify some possible uses for treated wastewater;
- provide treated wastewater quality guidelines for the protection of human health and the environment;
- recommend treatment levels, safeguards and controls;
- describe best environmental management practices for reuse systems;
- stipulate the requirements for sound monitoring programs; and
- outline the statutory approvals required to implement a wastewater reuse system.

The EPP acknowledges that acceptable water quality requirements must be very carefully established. Too little emphasis on water quality requirements will lead to situations of unacceptable impact, while too stringent requirements will make treatment costs commercially non viable.

3.1 Wastewater Sources

Wastewater is defined as liquid wastes normally collected in a sewer system and processed in a treatment plant. Wastewater from residential areas comprises two components, blackwater which is toilet discharge and greywater which is shower, washing machine and kitchen sink discharge.

For the purposes of this EPP, wastewater sources are restricted to sewage from:

- sewer lines servicing individual blocks where treatment, disinfection and re-use occurs on site;
- trunk sewers where water can be extracted for treatment in a package treatment plant to meet significant local demand; and
- fully treated effluent from sewage treatment plants.

Grey water such as that from laundry washing, bathing and showering is a particular class of wastewater and its reuse is gaining popularity. Best management practices aimed at minimising health and environmental risks associated with grey water reuse on single residential blocks are provided in a pamphlet titled *'Greywater'* is available from the Environment ACT Information Centre in Macarthur House, 12 Wattle Street, Lyneham or by calling the Information Centre Helpline on 6207 9777.

Wastewater does not include stormwater.

The suitability of industrial wastewater for reuse and associated treatment requirements are industry specific. The limited industrial base of the ACT and the complexities of defining acceptable treatment requirements places the reuse of industrial wastewater beyond the scope of this EPP. Advice on a specific industrial wastewater reuse proposal can be obtained by telephoning the Environment ACT Information Centre Helpline on 62079777.

3.2 Wastewater Uses

While this EPP focuses on reuse for irrigation, effluent guidelines and recommended treatments are provided for some other uses on the next page in Table 1.

Table 1 Health Guidelines for Effluent Reuse[1]

Type of Reuse	Suggested Level of Treatment	Reclaimed Water Quality	Monitoring[3] <3ML/Year	Monitoring[3] >3ML/Year	Controls/Notes
Municipal irrigation, dust suppression, ornamental water bodies – **uncontrolled public access** (except for sub-surface irrigation – see below)	Secondary + pathogen reduction by disinfection, ponding or filtration	Thermotolerant coliforms - median value of <10 cfu/100 ml ≥1 mg/L Chlorine residual after 30 min or equivalent level of pathogen reduction[4] pH 6.5 - 8.0 (90% compliance) ≤ 2NTU[2]	Weekly initially for 3 months, then monthly Weekly Weekly As required	Weekly initially for 3 months, then monthly Daily Weekly Continuous	Systems using detention only do not provide reduction of thermotolerant coliform counts to <10 cfu/100 ml and are unsuitable as sole means of pathogen reduction for high contact uses. Note: Thermotolerant coliforms value is to be reviewed for the ARMCANZ, ANZECC, NHMRC Guidelines on which this Table is based in view of the fact that the median value for primary contact recreation is 150 cfu/100 ml
Municipal irrigation, dust suppression - **controlled public access** Sub-surface Irrigation for all purposes. Horticulture	Secondary + pathogen reduction by disinfection or ponding Secondary Secondary	Thermotolerant coliforms - median value of <1000 cfu/100 ml ≥1 mg/L Chlorine residual after 30 min or equivalent level of pathogen reduction Suspended Solids or Turbidity pH 6.5 - 8.0 (90% compliance)	3 Monthly Weekly Monthly Monthly	Monthly Daily Monthly Monthly	
Residential: Garden watering Toilet flushing Car washing Path/wall washing	Secondary + filtration + pathogen reduction	Thermotolerant coliforms - median value of <10 cfu/100 ml ≥1 mg/L Chlorine residual after 30 min or equivalent level of pathogen reduction[4] pH 6.5 - 8.0 (90% compliance) ≤ 2NTU[2]	Weekly initially for 3 months, then monthly Weekly Weekly As required	Weekly Daily Weekly Continuous	Plumbing controls **Note: Thermotolerant coliforms value is to be reviewed for the** ARMCANZ, ANZECC, NHMRC **Guidelines on which this Table is based in view of the fact that the standard for primary contact recreation is 150 cfu/100 ml.**
Pasture and fodder for grazing animals (except pigs)	Secondary + pathogen reduction by disinfection or detention in ponds or lagoons	Thermotolerant coliforms - median value of <1000 cfu/100 ml Disinfection systems pH 6.5 - 8.0 (90% compliance)	Weekly Weekly Weekly	Weekly Daily Weekly	Withholding period of nominally 4 hours for irrigated pasture. Drying or ensiling of fodder. Helminth control. Grazing only where no ponding remains.
Silviculture, turf and non food crops	Secondary	Thermotolerant coliforms - median value of <10000 cfu/100 ml PH 6.5 – 8.5	Monthly Weekly	Monthly Weekly	Restricted **public access**. Withholding period 4 hours.

Table 1 Continued

Type of Reuse	Suggested Level of Treatment	Reclaimed Water Quality	Monitoring [3] <3ML	Monitoring [3] >3ML	Controls/Notes
Food crops in direct contact with water eg sprays	Secondary + filtration + pathogen reduction	Thermotolerant coliforms - median value of <10 cfu/100 ml ≥1 mg/L Chlorine residual after 30 min or equivalent level of pathogen reduction[4] pH 6.5 - 8.0 (90% compliance) ≤ 2NTU	Weekly Daily Weekly As required	Weekly Daily Weekly Continuous	A minimum of 25 days ponding or equivalent treatment (eg sand filtration) for helminth control.
Food crops not in direct contact with water (eg flood or furrow) or which will be sold to consumers cooked or processed	Secondary + pathogen reduction	Thermotolerant coliforms - median value of <1000 cfu/100 ml Biological Oxygen Demand/Suspended Solids pH 6.5 - 8.0 (90% compliance)	Weekly Monthly Weekly	Weekly Weekly Weekly	Crops must be cooked (>70°C for 2 minutes) commercially processed or peeled before consumption.
Ornamental waterbodies - restricted access	Secondary	Thermotolerant coliforms median value of <1,000 cfu/100 ml Disinfection systems	Monthly Weekly	Weekly Daily	Surface films absent
Aquaculture Non-human food chain	Secondary Maturation ponds (5 days retention)	Thermotolerant coliforms median value of <10,000 cfu/100 ml TDS <1000 mg/L	Monthly	Weekly	
Aquaculture Human food chain	Secondary + Filtration Pathogen reduction	Thermotolerant coliforms - median value of <10 cfu/100 ml ≥1 mg/L chlorine residual after 30 min or equivalent level of pathogen reduction [4] pH 6.5 - 8.0 (90% compliance) ≤ 2NTU	Weekly Daily Weekly As required	Weekly Daily Weekly Continuous	Toxicant, dissolved oxygen and salinity controls may be required.

1 Source:-NWQMS Guidelines for Sewerage Systems - Use of Reclaimed Water, ARMCANZ, ANZECC, NHMRC.

2 Limit met prior to disinfection. 24 hour mean value. 5 NTU maximum value not to be exceeded.

3 These are the recommended maximum monitoring regimes only. The adoption of best management practices, demonstrated effluent quality and the risk to public health will be taken into account by the relevant authorities to determine the level of monitoring required.

4 Chlorine residual of ≥1 mg/L after 30 min of chlorine contact ensures adequate disinfection. Where there is the potential to discharge to receiving waters effluent should be either dechlorinated or held until chlorine residual is <0.5 mg/L.

Table 2 Environmental Guidelines for Effluent Reuse – Irrigation[1]

Parameter	Effluent Standard	Effluent Monitoring[2] <3ML/Year	Effluent Monitoring[2] >3ML/Year	Notes/Impact Monitoring
Nutrient levels	Nutrient loads should be balanced with plant requirements	Initial and 6 monthly monitoring of effluent for P and N is required.	Initial and 3 monthly monitoring of effluent for P and N is required.	Nutrient balance calculations should be carried out pre-commissioning to determine the fate of nitrogen and phosphorus. (See Text) Elevated nutrients in groundwater may render the groundwater unsuitable for stock and domestic water supplies. Nitrate is a health risk to humans at 10mg N/L and animals at 30 mg N/L. Groundwater should be monitored annually for nitrate.
Total Dissolved Solids Electrical Conductivity	500 mg/L 800 µs/cm	Initial and 6 monthly monitoring for TDS or EC is required.	Initial and 3monthly monitoring for TDS or EC is required.	Without leaching and drainage, salts may be redistributed towards the soil surface by the upward movement of water associated with evaporation. Thus, periodic monitoring of soil salinity at suitable depth intervals is required. Groundwater should also be monitored periodically.
Sodium Adsorption Ratio	< 6	Initial monitoring SAR is required.	Initial monitoring SAR is required.	The structure of the clay in the soil can be damaged when the ratio of sodium to calcium and magnesium, combined with the salinity of the effluent are high enough to cause large changes to the sodium status of the soil. This leads to permeability and aeration problems. Effluent with an SAR of 3 or more has the potential to cause structural decline, and effluents with SAR >6 should only be used with caution. Monitoring of soil structural stability and/or permeability should be carried out periodically to detect deterioration.
Biochemical oxygen demand	Organic load should be at a rate of ≤40 kg/ha/day	Initial monitoring of BOD is required.	Initial and 3monthly monitoring of BOD is required.	High organic loading may lead to a reduction in the infiltration capacity of the soil. Monitoring of organic matter and soil structure should be carried out annually to detect deterioration which may be caused by effluent irrigation.
Acidity (pH units)	6.5-8.5	Covered in Table 1	Covered in Table 1	Soil pH affects the availability of nutrients to plants. Soil pH should be monitored at suitable depth intervals every 5 years or if problems of plant growth are observed.
Chlorine residual	< 0.5 mg/L where runoff is likely to enter receiving waters			Where runoff is likely to enter receiving waters, effluent should be either dechlorinated or held until the chlorine degrades from the recommended level for disinfection to <0.5 mg/L.
Heavy metals/restricted substances	See Table 3	Monitoring required only if effluent is derived from industrial estates.	Monitoring required only if effluent is derived from industrial estates.	Monitoring of the top 100 mm of soil is required only if effluent is derived from potential sources of metals such as industrial estates.

1 Source:The Utilisation of Treated Effluent by Irrigation , EPA NSW, 1995.

2 These are the recommended <u>maximum</u> monitoring regimes only. The adoption of best management practices, demonstrated effluent quality and the risk to public health will be taken into account by the relevant authorities to determine the level of monitoring required.

4 EFFLUENT QUALITY

4.1 Health requirements

Effluent Guidelines

Effluent guidelines for the protection of public health are outlined in Table 1 and include:

- thermotolerant coliform levels as an end point bacterial indicator of faecal contamination;
- final disinfection chlorine residual and/or biocide contact time; and
- physical and chemical water quality that minimises conditions favourable to regrowth of pathogenic micro-organisms and nuisance slimes.

Levels of Treatment

Table 1 provides suggested levels of treatment which are a means of achieving acceptable endpoint microbiological and chemical safety guidelines. The guidelines recognise that technologies are evolving rapidly and that there is a need to encourage treatment innovation. Assurances of adequate treatment should be established by:

- demonstrated performance against microbiological criteria through monitoring as determined by the relevant authorities; or
- demonstrating that treatment processes are satisfactory to achieve the desired water quality outcomes (some initial and ongoing monitoring would still be required).

4.2 Environmental requirements

Effluent guidelines for environment protection are summarised in Table 2. The constituents of treated sewage effluent which may impact on the environment are discussed below.

Nutrients

The nutrients present in effluent which are most likely to be utilised by plants are nitrogen, phosphorus and potassium. Since full utilisation of nutrients is the goal of effluent irrigation schemes, the need to remove nutrients from effluent at the treatment stage is dependent on the potential of these nutrients to accumulate to unacceptable levels in soils, or impact significantly on receiving waters.

Nitrogen may be present at concentrations ranging between 10 to 50 mg N/L in a variety of chemical forms: organic, ammonia, nitrate and nitrite. All forms of nitrogen are transformed in the soil to nitrate. Nitrate in excess of plant requirements may be carried through the soil to the groundwater. Elevated nitrogen levels may render groundwater unsuitable for stock and domestic water supplies. Nitrate is a health risk to humans at more than 10 mg N/L and animals at more than 30 mg N/L.

Phosphorus concentrations in treated sewage effluent are normally up to 10 mg/L. Application at this rate will usually be advantageous agronomically without causing overloading problems. However, irrigation with this concentration of P may cause overloading in some soils, leading to potential contamination of groundwater. If the surface soil texture indicates that the soil may have little ability to retain P, then the phosphorus sorption capacity of the soil as described in Table 4 should be measured to determine the risk of groundwater contamination.

Potassium in sewage effluent is usually present at concentrations which are too low for optimum plant growth.

The rate of application of nutrients in irrigated effluent should be determined prior to irrigation. In conducting a mass balance for nutrients, the amount of the specific nutrient to be applied in the effluent per year should be compared with the amount taken up by biological or physical processes associated with the crop/soil system. The amount of plant material removed from the site may also need to be taken into account in situations where nutrient levels in the effluent are similar to plant uptake. Normal fertilising regimes should be reduced for irrigated playing fields or pasture to take advantage of the nutrient content of wastewater.

Salinity

The Total Dissolved Solids value of effluent is an important determinant of the effluent's suitability for land application. Municipal sewage effluents usually contain around 500 mg/L of TDS (or an electrical conductivity of approximately 800 µS/cm), and their application to land usually has limited impact on soil salinity levels if an adequate amount of leaching occurs.

With each effluent application, the salt concentration in the root zone progressively increases. Without the downward water flow associated with leaching and drainage, salts may be redistributed towards the soil surface by the upward movement of water in the soil associated with evaporation. It is therefore desirable to select a site having soil with sufficiently high permeability to permit adequate leaching.

Thus, the effective operation of a viable, lasting effluent irrigation system requires periodic monitoring of the levels and distribution of soil salinity, particularly within the root zone areas. It is recommended that monitoring of soil salinity at suitable depth intervals within the root zone be carried out prior to the commencement and at the end of the irrigation season each year.

Sodium Adsorption Ratio

Permeability and aeration (waterlogging) problems can occur when the irrigation water has an Sodium Adsorption Ratio (SAR) and salinity high enough to cause a large increase in the sodium status of the soil. These values will be different for different soil and land uses, but in general irrigation water with an SAR of 3 or more has the potential to cause an increase in soil sodicity and the consequent management problems and effluents with SAR >6 should be used with caution. Monitoring of soil structural stability and/or permeability should be carried out periodically to detect deterioration that may adversely affect continued effluent irrigation or future land use. The frequency of monitoring required will be determined by the SAR and salinity of the effluent.

SAR as shown in the following equation defines the relationship between sodium, calcium and magnesium.

$$\mathbf{SAR} = \frac{\mathbf{Na}^{+}}{\sqrt{\left(\frac{\mathbf{Ca}^{++} + \mathbf{Mg}^{++}}{\mathbf{2}}\right)}}$$

Where Na, Ca and Mg are ionic concentrations in milliequivalents per litre.

Permeability and aeration problems can occur when irrigation water has an SAR above 6. The SAR for typical municipal effluents seldom exceeds a value of 5 to 8. For the majority of ACT soils, effluent with a SAR value of less than 8.0 and an electrical conductivity value of less than 500µS/cm is likely to be safe. However, soil damage may occur at low SAR when combined with high pH and salinity. Monitoring of soil structure should be carried out periodically to detect deterioration which may be caused by effluent irrigation.

Biological Oxygen Demand

Organics in effluent can revitalise soil fertility when applied at an appropriate rate, but continued overloading of organic matter may physically clog soil pores and favour anaerobic microbiological populations in the soil. Organic loading rates may influence liquid loading rates and the length of the resting period between applications required to permit re-aeration of the soil.

An organic loading rate of 40 kg/ha/day BOD is recommended as maximum for most soils.

pH

Soil pH affects the availability of nutrients to plants. Effluent within the range of 6.5 to 8.5 is acceptable for irrigation.

Suspended Solids

The concentration of suspended solids should be such that it does not cause operational problems with irrigation systems or interfere with the disinfection system.

Metals

Although some metals are essential for plant growth, many are toxic at high concentrations. Metals are only of concern if effluent is derived from potential sources such as industrial estates. The following maximum concentrations of metals in irrigation waters have been developed.

Table 3 Maximum Concentration of Metals in Irrigation Waters[1]

Element	Tot Conc mg/L	Element	Tot Conc mg/L
Aluminium	5.00	Arsenic	0.10
Beryllium	0.10	Cadmium	0.01
Chromium	0.10	Cobalt	0.05
Copper	0.20	Iron	1.00
Lead	0.20	Lithium	2.50
Manganese	0.20	Mercury [2]	-
Molybdenum	0.01	Nickel	0.20
Selenium	0.02	Zinc	2.00

Topsoil concentrations of heavy metals and trace elements should be in accordance with the *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites,* ANZECC & NHMRC, 1992.

[1] Source:- ANZECC (1992)

[2] No guideline recommended at this time.

Organic Compounds

Persistent and harmful pesticides such as organochlorine pesticides (OCs) and herbicides such as 2,4-D, 2,4,5-T and their derivatives are banned in the ACT and as such are not of concern in this context. Pesticides and herbicides which are available in the ACT are unlikely to enter the sewer system and in any case would be bound to the sludge and organic matter. Organic compounds such as phenols and surfactants are usually present in sewage effluent at low concentrations.

Petroleum hydrocarbons, which are the most common hydrocarbon contaminants of wastewater in the ACT are largely removed by wastewater treatment.

5 BEST MANAGEMENT PRACTICES

5.1 Health Related Safeguards and Controls

Plumbing

Where reclaimed water is piped to the site where it is to be used, there is a risk that the reclaimed water pipe could be mistaken for a potable water supply and cross connection could occur. To minimise the risk of cross connection and backflow the following measures are recommended:

- written plans for the maintenance of complete pipeline system;
- appropriate pipeline identification;
- education of owner and operator(s); and
- surveillance of operation and inspection of modifications to the reclaimed water system.

If potable water is supplied into the reclaimed water system as make-up water, an approved air gap meeting the requirements of AS 3500 must be installed in the potable supply at the point where it enters the system.

To protect the potable supply from backflow in the event of a cross connection, the reclaimed water system should be operated at a lower pressure than the potable system. Pressure taps should also be provided to permit in situ testing for correct operation.

All pressure piping used for the reclaimed water system must be readily identifiable and distinguishable from potable water piping an the same site. Pipes and taps should be colour coded deep purple and/or marked with the words ***Reclaimed Water - NOT FOR DRINKING*** and connected to hoses by non standard fittings. They should also display the recommended International Public Information-Drinking Water Symbol with the Prohibition Overlay (ISO Standard 7001 plus appendum).

For above ground installations, non potable water services should not be installed within 100 millimetres of parallel potable water supply. Below ground installations of non-potable water services should not be installed within 300 millimeters of any parallel water supply. Where reclaimed water is provided to residential areas as a piped non-potable supply, the minimum inspection frequency of the reclaimed water system should be:

- all new services at installation;
- all services on change of ownership; and
- all services following completion of property extensions or plumbing modifications.

Irrigation Systems

Although an effluent has a low count of thermotolerant coliforms and is disinfected, this does not necessarily mean the absence of bacterial, protozoan and viral pathogens. Systems are therefore recommended which minimise human contact (such as sub-surface irrigation) particularly where there is uncontrolled public access. However, the additional cost and the inflexibility of these systems needs to be considered.

Where above-ground irrigation is adopted, sprinklers which produce coarse droplets and not a fine mist should be used to minimise the risk of aerosol dispersion by wind drift.

For effluent which is not suitable for public access, spray irrigation systems should be surrounded by vegetative buffer zones and should not be sited in proximity to dwellings, public roads or parks. In general, a buffer zone of 50 metres for aerosols and 20 metres for low rise sprays should be provided around the perimeter of the site. Alternatively, irrigation could be carried out at night. Care should be taken to prevent surface flow or seepage into neighbouring areas.

Storage

Where reclaimed water may be unsuitable for use due to treatment failure or the normal reclaimed water application is not available, there is a need for the system operator to have available alternative storage and/or disposal options of adequate capacity. Care should be taken to prevent septicity taking place in the storage tanks or ponds. Disinfection may be required prior to use. Storage requirements are also discussed on page 17.

5.2 Environment Protection Related Safeguards and Controls

Although treated effluent may meet the appropriate public health guidelines for application, there is the potential for environmental harm to occur, particularly as a result of nutrients and salts finding their way into receiving waters and a build up of salts in the soil. Best management practices need to be adopted to reduce the likelihood of environmental harm. These practices will vary according to different circumstances.

The following factors need to be taken into account in determining the suitability of the site and the irrigation system:

- proposed or existing land use;
- site features including;
  - topography;
  - drainage characteristics including proximity to waterbodies;
  - depth to groundwater;
  - soil permeability;
  - vegetation;
  - public access and proximity to dwellings;
- water balance for the site;
- storage provisions for periods of wet weather when the soil is saturated;
- nutrient balance assessment for the site (see page 7); and
- appropriate design, installation and maintenance requirements for such systems.

Site Selection

Topography

Slopes up to 15 percent are acceptable for pasture irrigation, provided runoff and erosion are strictly controlled. Steep slopes can be used for plants such as trees and vines which are trickle irrigated. Retention banks may need to be built to prevent runoff from the site. Diversion drains upslope may be required to control the flow of stormwater onto the site.

Proximity to Waterbodies

The site should be least 500 metres from any surface water which is used as a domestic supply. The distance from natural watercourses will depend on the quality of the effluent, slope and permeability of the site.

Groundwater

Maintenance of a minimum depth of about three metres to groundwater is normally necessary to maintain aerobic conditions in the soil and prevent surface waterlogging.

Groundwater must be protected from contamination by irrigated effluent. Of particular concern is the potential contamination by nitrogen compounds, salts and toxic contaminants.

Irrigation should normally be on a moisture deficit basis. A program to monitor soil water content combined with strategies to suspend irrigation when soil moisture content is high is desirable. Measurements of rainfall and pan evaporation with occasional checks against soil moisture would also be acceptable.

Things to consider regarding the impact of effluent irrigation on groundwater are:

- existing groundwater quality;
- effects of dilution; and
- proximity to groundwater discharge sites or water supply wells.

The extent of dilution will depend on the rate of flow of the groundwater beneath the site, which in turn depends on aquifer permeability and hydraulic gradient (slope of the water table). The amount of dilution will also depend on the size of the effluent irrigation area; a large area will have greater effect on groundwater quality than a small one because there will be less dilution of the larger total mass of salt and nitrate coming from the larger area.

Baseline groundwater monitoring should be established to enable deterioration of groundwater quality to be detected.

Soil

One of the most important considerations in site selection is the soil. It needs to be suitable both for plant growth as well as for buffering potential impacts on surface and groundwater resources. The most important soil chemical and physical properties that may indicate restrictions to effluent irrigation are listed in Table 4. Sites with *moderate limitations* are likely to present sub-optimal conditions and will require more careful design and monitoring programs, while those with *severe limitations* should not be considered for effluent irrigation. Where *slight limitations* are indicated they are unlikely to cause concern under most circumstances. However, in combination with other limitations they may indicate poor suitability of a site.

The most suitable soils are moderately permeable and deep with a good water storage capacity. Sandy and gravelly soils at one extreme and heavy clay soils at the other are the least suitable. The poor holding capacity of sandy and gravelly soils means that much of the effluent may drain below the root zone before trees can take advantage of it, requiring more frequent irrigation and resulting in rapid movement to groundwater. Heavy clay soils are likely to be the least permeable, although this is not necessarily the case if they are well structured. They are the most susceptible to decline in permeability as a result of chemical and physical changes during effluent irrigation. Soils with a low permeability and infiltration capacity are more likely to be subject to runoff (leading to potential contamination of surface water with nutrients) and waterlogging. These difficulties may be compounded by dissolved salts including sodium ions in the effluent.

Slightly acid soils (pH 5 - 6) are generally most suitable, balancing the slight alkalinity of many effluents. Soils that are too acid (pH <4) or too alkaline (pH >8.5) are likely to be too restricting to plant growth and to indicate other soil problems that may be limiting.

Soil depths in excess of 1.5 metres throughout the site are preferred to provide for the efficient utilisation of applied effluent. Lesser depths may be acceptable where shallow rooted pasture plants are cultivated.

Table 4 Soil limitations for effluent irrigation [1]

Soil Property	Limitation			Restrictive aspects
	slight	moderate	severe	
Hydraulic conductivity, (mm/hour) - Topsoil - Subsoil to 1 m	 20 - 80 20 - 80	 5 - 20 1 - 20	 <5 <1	 excess runoff waterlogging
Phosphate sorption index (average of 0.-1 m) [(mg/kg)/(log$_{10}$ μg/L)]	>100	10 - 100	< 10	acts as a poor filter leaching of phosphorus to groundwater
pH (in $CaCl_2$)	5 - 8	4 - 5	< 4, > 8.5	reduces optimum plant growth

1 Source: *Principles and Practice of Effluent Irrigated Plantations: A Practical Guide, CSIRO 1998*

Water Balance - Irrigation Area

The minimum area required is determined by calculating the area required for acceptable loading of each parameter (hydraulic, organic, nutrient or other parameters in Table 2) and selecting the largest of these areas.

The irrigation area based on the acceptable hydraulic loading should be calculated based on the average monthly rainfall and evapotranspiration rate and take into account soil percolation rate. Table 5 below provides an estimation of irrigation needs for design purposes only, not for irrigation scheduling. Site specific requirements will depend on soil type and vegetation.

Table 5 Average Irrigation Requirements for the ACT*

MONTH	Average monthly Rainfall (mm)	Average Monthly PAN Evaporation (mm)	Crop Factor*	Average Evapo-Trans-piration* (mm)	Average Irrigation Needs (mm)	Average Irrigation Needs Kilolitres/ Ha/Mth
January	63	252	0.9	227	164	1640
February	55	200	0.9	180	125	1250
March	54	270	0.85	145	91	910
April	51	107	0.8	86	35	350
May	49	68	0.7	48	0	0
June	38	46	0.55	25	0	0
July	42	52	0.55	29	0	0
August	46	80	0.65	52	6	60
September	51	112	0.75	84	33	330
October	66	158	0.85	134	68	680
November	64	193	0.9	174	110	1100
December	53	250	0.9	225	172	1720

*Grasses

Nutrient and organic loadings should be based on the irrigation demand (Table 5) and the concentrations of these parameters in the effluent as follows:

$$\mathbf{LR} = \frac{\mathbf{AR * Conc}}{\mathbf{1,000,000}}$$

Where: **LR** = Load Rate (kilograms/hectare/year)
AR = Application Rate (litres/hectare/year)
Conc = Concentration (milligrams/litre)

Load Rate should be compared with the expected export of nutrients from the site as a result of plant uptake and any other biological or physical processes. If the Load Rate exceeds the potential for export, then the area required based on the nutrient load should be calculated as:

$$\textbf{Area} = \frac{\textbf{EV * Conc}}{\textbf{1,000,000 * NE}}$$

Where: **Area** = hectares
EV = Effluent Volume (litres/year)
Conc = Concentration (milligrams/litre)
NE = Nutrient Export (kilograms/hectare/year)

Effluent should not be applied if soil moisture conditions are such that surface runoff or ponding is likely to occur. Irrigation of effluent should only be carried out under dry weather conditions. If groundwater is a concern, effluent should only be applied when there is a soil moisture deficit.

Good irrigation practice requires well defined rest periods within the program to provide an opportunity for the applied water to be evapotranspired, and for soil micro-organisms to break down the organic matter contained in the effluent.

Runoff from the catchment above the irrigation area may need to be diverted to reduce discharge from the site, and the area to be irrigated should ideally be as level as possible.

Storage Requirements

Irrigation is not required at times when rainfall is sufficient to meet soil moisture deficit. Wet weather storage (or an alternate disposal method) is required in effluent irrigation schemes because the amount of effluent produced by treatment plants cannot usually be varied in response to wet weather conditions. Storage is also usually required for effluent generated in the cooler months when low evapotranspiration rates restrict the full-scale application of effluent (for example see Table 5 May to August).

Monthly precipitation and evaporation data should be analysed to determine how often there may need to be a temporary reduction or cessation of effluent irrigation and the resultant storage requirements.

The site planned for storage lagoons should be carefully investigated and adequately designed to prevent seepage losses (eg lined with compacted clay, synthetic membranes) and maintain adequate freeboard.

It should be remembered that when effluent containing nutrients is stored for long periods there is a likelihood that algal blooms will develop. In such situations, all humans and animals should be excluded from contact with the water. Irrigation with the effluent should stop at once. Environment ACT should be notified for further advice. Oxygenation of effluent may assist in preventing algal growth.

Storage is not required where sewer mining is on a demand basis with the option of diverting the effluent to the sewer system during periods when irrigation is not required.

Storage may also not be required in circumstances where the quality of effluent is such that an authorisation may be obtained to discharge to receiving waters as required.

Irrigation Methods

All irrigation pipework and fittings in the system should comply with AS 1477 or AS 2698.2 - *Plastic pipes and fittings for irrigation and rural applications.* Irrigation systems are to be permanently fixed with distribution pipelines buried at least 100 mm. A typical sub-surface irrigation system is described in AS 1547-1994.

Environmental concerns can be minimised by ensuring schemes have in-built safety features such as cut-off systems to prevent irrigation during storms and when there is no moisture deficit in the soil. Sub-surface systems in particular require a monitoring system to detect blockages.

Performance Monitoring

The appropriate monitoring regime will be determined by the relevant authorities and will depend on the reliability of the treatment process, the method of irrigation and the risk to public health and the environment.

Monitoring regimes in Table 1 which are consistent with the national guidelines are the maximum recommended where there may be a risk to public health. However, demonstration that treatment processes are satisfactory and that best management practices are maintained is an acceptable alternative to regular monitoring. Initial and periodic monitoring may be required to establish effluent quality and the reliability of the treatment process.

Depending on the type of reuse, the Health Protection Service normally require that monitoring results be provided on a regular basis and be notified when there is a failure of the system operation and the water quality requirements

Table 2 provides guidance on monitoring which addresses environmental concerns specific to wastewater reuse. Initial and periodic monitoring of soil and groundwater is required to determine if there is any deterioration in quality as a result of wastewater reuse.

Monitoring of soil and groundwater is also used to signal that changes in the wastewater use practices are required. The following practices should also be adopted:

- maintenance of records of monitoring data which should be made available for review by relevant authorities on request; and
- the utilisation of laboratories with demonstrated reliability and quality of analysis for analysis of samples to ensure the accuracy of monitoring data.

6 APPROVALS PROCESS

6.1 Planning

All proposals involving infrastructure will require formal construction approval through the Development Application (for non-residential area) or Building Application (residential area) process. Applications may also require formal assessment of potential environmental impacts under Part IV of the *Land (Planning and Environment) Act 1991.*

6.2 Environment Protection

Under the *Environment Protection Act 1997* a person conducting:

- the treatment of wastewater for reuse in excess of three megalitres per year;
- the reuse of wastewater, in excess of three megalitres per year; or
- in circumstances where the Environment Management Authority (EMA) is concerned that there is a risk of environmental harm;

is required to hold an Environment Protection Agreement with the EMA or a current Environmental Authorisation for the activity.

In developing the Environment Protection Agreement the person must have regard to the following:

- these wastewater reuse guidelines; and
- environmental values as outlined in the Territory Plan where there is a potential for runoff to enter receiving waters.

In setting conditions for an Environmental Authorisation, the EMA will consider the same matters listed above.

6.3 Health

The applicant should apply in writing to the Health Protection Service, ACT Health and Community Care for approval of any wastewater reuse system. The application should include information as described below.

Prospective applicants are advised to discuss their proposal with the Health Protection Service on (02) 62051700 before submitting the application.

6.4 Information Required To Assess Effluent Irrigation Proposals

The following information should be provided in circumstances where an assessment of the environmental and health impacts of a wastewater irrigation system is required.

- A detailed description of the treatment process including a layout plan design capacity;
- Performance specification including the quantity, rate and quality of the effluent produced. Data will be required to substantiate expected quality from the treatment system. This may be obtained from an existing system or similar systems elsewhere in the case of a proposed new system;
- Information on effluent quality should be provided for the following parameters:
  - Thermotolerant coliforms
  - Total Phosphorus
  - Total Nitrogen
  - Sodium Absorption Ratio
  - Acidity (pH)
  - Total Dissolved Solids
  - Suspended Solids
  - Biological Oxygen Demand;
- A preliminary description of the health and environmental impacts of the proposed system;
- Details of safeguards and controls that are required under this guideline;
- A description of the irrigation system;
- A description of the site to be irrigated including the following:
  - proposed or existing land use
  - area
  - topography
  - drainage patterns including proximity to waterbodies
  - depth to groundwater
  - soil permeability
  - public access;
- A water balance for the irrigation site including rainfall and evapotranspiration;
- A nutrient balance for the irrigation site;
- Storage provision for periods of wet weather when the soil is saturated;
- Details of performance monitoring regime; and
- Any other information required to assess the proposal as necessary.

7 Background documentation

Guidelines for Sewerage Systems - Use of Reclaimed Water, Agriculture and Resource Management Council of Australia and New Zealand - Australian and New Zealand Environment and Conservation Council - National Health and Medical Research Council, 1996.

Guidelines for the Utilisation of Treated Effluent by Irrigation, New South Wales Environment Protection Authority, *1995*.

New South Wales Guidelines for Urban and Residential Use of Reclaimed Water, NSW Recycled Water Coordination Committee, 1993.

Code of Practice for Domestic Wastewater, Victorian EPA, 1995

Australian Standard (AS 1547-1994), *Disposal systems for effluent from domestic premises.*

Effluent Irrigated Plantations: Design and Management, CSIRO, 1995.